Pre-construction Planning and Development Phase for Homestake Deep Underground Science and Engineering Laboratory

We are developing the Preliminary Design Report for the National Science Foundation (NSF) to

Richard DiGennaro, LBNL
Project Manager
Systems Engineer

Develop the DUSEL Facility Design:

- Integrate plans for the Initial Suite of Experiments with Facility Design
- Prepare preliminary design drawings and specifications
- Preliminary Base-line Cost and Schedule Estimate
- Integrated Risk Analysis and Contingency Estimates
- Facility Operations Cost Estimate
- Environmental Assessments

Define Processes for Construction Management:

- Project Execution Plan
- Project Management Control System
- Systems Engineering and Risk Management

Homestake DUSEL Project Status (Preconstruction Planning)

- **Objective:**

  To design and build an international, multidisciplinary facility for underground science and engineering research at the site of the former Homestake Gold Mine in Lead, South Dakota.

- **Funding from the State of South Dakota and Private Donations for "Mining-to-Laboratory" Conversion:** **~$110M**

  Work is underway to prepare underground space for early experiments.

- **NSF Pre-Construction Funding:** **$15M**

  We have 3 years of funding for Pre-construction Planning and Development, average $5M per year (FY 2008 – FY2010).

- **Proposed NSF Funding for Construction:** **~$550M**

  ~ 50% is slated to develop an **Initial Suite of Experiments** and

  ~ 50% for **Facility Design and Construction.**

- **The proposed construction duration with NSF Funding is 2012 through 2018.**

Pre-construction Review Process

- **Pre-construction planning proceeds through a sequential process of science community development, NSF oversight and review:**
  - **Definition of Science goals –** ✔
    - What science goals will the proponents achieve in this new facility?
  - **Conceptual Design Stage -** ✔
    - Description of functional requirements, top-down parametric cost estimates, rules of thumb for risk and schedule estimation, preliminary cost estimates for operations, project execution planning
  - **Preliminary Design Stage (or "Readiness Stage")**
    - Site-dependent description of all major functional elements, bottom-up cost estimates, risk assessment, schedule derived from Project Mgt Control System, partnerships, refined cost estimate for operations, Project Execution Plan
  - **Final Design Stage (or "Board Approved Stage")**
    - "Construction-ready" drawings, specifications, budgets and contingencies, Final Project Execution and Risk Management Plans.

• DUSEL Pre-construction Timetable - Key Milestone Targets

Oct-2007	Start: Preconstruction Planning and Development READINESS Stage
Nov-2007	DUSEL Town Meeting, Washington D.C
Apr-2008	Initial Suite of Experiments Workshops, Lead, SD
Jul-2008	Internal Design Review - Pre-construction Planning and Development
Dec-2008	NSF Annual Review: Draft Preliminary Design Presentation
Jun-2009	Preliminary Design Review, Draft Preliminary Design Report (Faciliity)
Oct-2009	Preliminary Design Report and NSF Annual Review (Facility and ISE)
Mar-2010	National Science Board Review
…	(Mid-year and Annual Reviews for Final Design)
FY-2012	DUSEL MREFC Construction Start

Immediate Priorities for Project Planning in early 2008

Geotechnical Studies and Mining Engineering

1. **Initiate site investigations, core-drilling, and geotechnical studies** for excavation and development of new space at 300 and 4850 levels

2. **Prepare Scope of Work and Excavation Plan** for space at 300 and 4850 levels, at a detail appropriate for the PDR, and sufficient to define the Basis of Estimates, Estimated Costs, and Construction Schedules, Contingency and Risk Analysis for the preliminary project baseline.

3. **Detailed Site Assessment and Requirements Definition** for Facility Infrastructure and Site Services to support Underground Construction and Operations

Homestake DUSEL Facility Project R&D Activities

Additional project research and development activities will be initiated to reduce project risk and to validate the preliminary design concepts:

- Development of site-specific safety standards, guidelines, training programs
- Management of hazardous materials and emergency response
- Large-scale, reduced-radon air supply
- Large-scale purified water systems for u/g labs and experimental equipment
- Large-scale clean room technologies for u/g installations
- Trade studies and criteria for u/g Lab Communications, Monitoring, Remote Operations, and Data Acquisition systems

Homestake DUSEL Institutional Roles and Responsibilities

- **University of California, Berkeley** is the sponsoring institution for NSF Funding

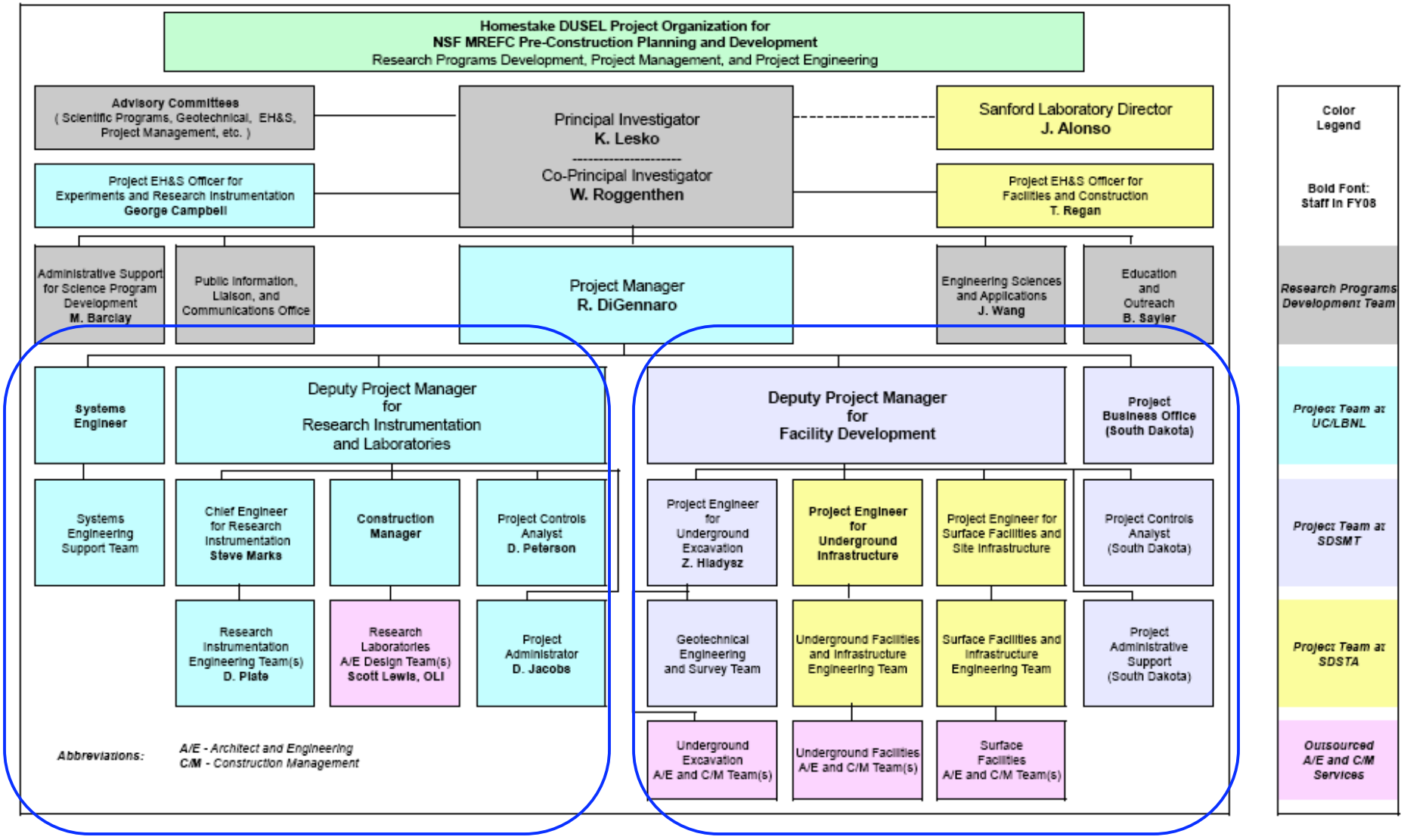
Institutional Responsibilities for DUSEL pre-construction planning and development:

  - **Lawrence Berkeley National Laboratory - Project Office**
    - » Integration of Research Programs and Initial Suite of Experiments
    - » Design of Underground Laboratories for the Initial Suite of Experiments
    - » Project Management and Systems Engineering
  - **South Dakota School of Mines and Technology - Satellite Project Office**
    - » Design and Construction Management of conventional facilities and infrastructure, new excavation
    - » Maintenance and Operations.
  - **Shared Responsibility for Environment, Health and Safety planning.**

- **South Dakota Science and Technology Authority (SDSTA)**

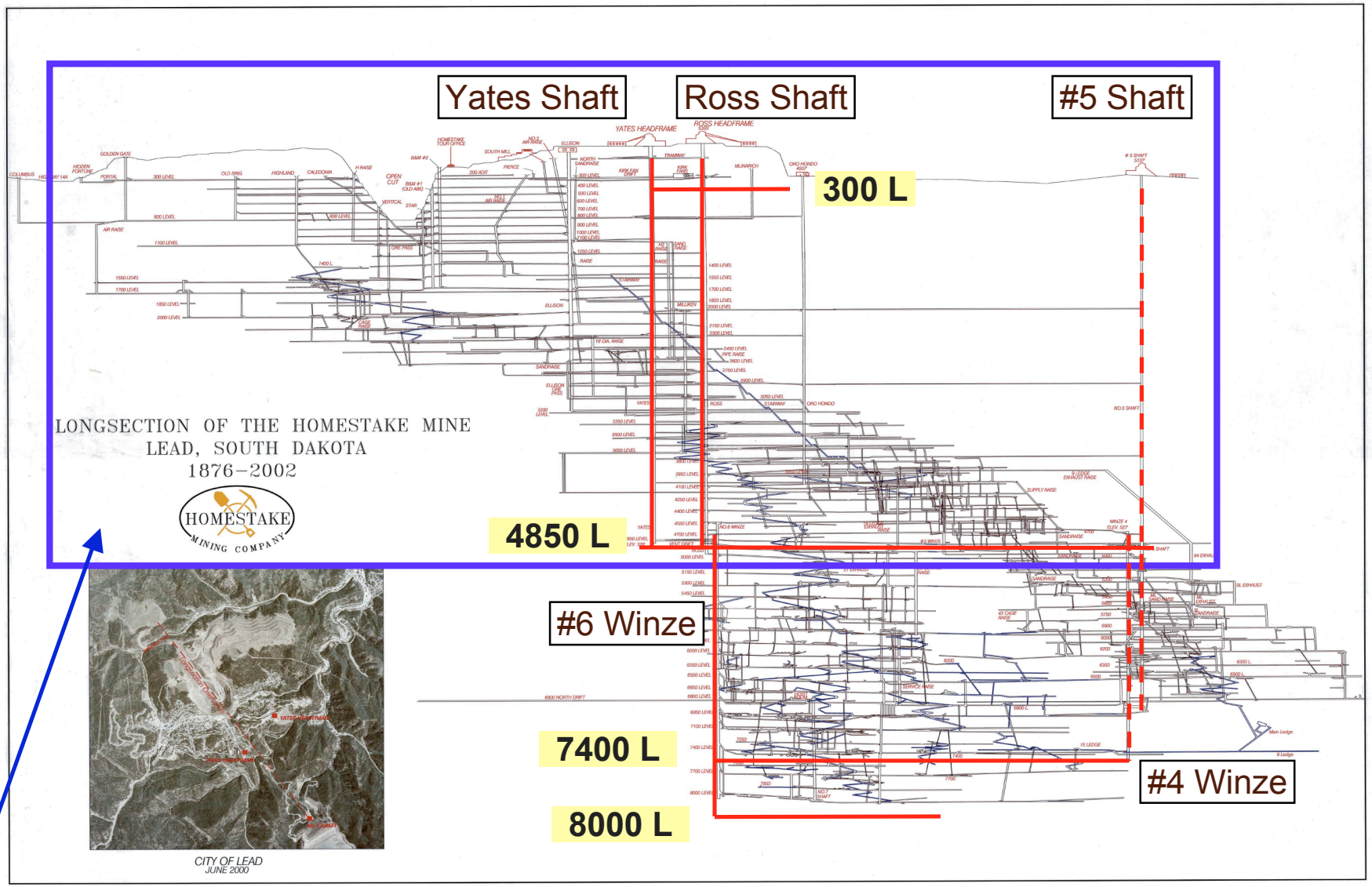
with state funding, will develop and manage the **Sanford Laboratory** as an interim facility for early experiments and for Education and Outreach, and prepare for DUSEL construction

Organizational Structure for NSF DUSEL Pre-construction Planning



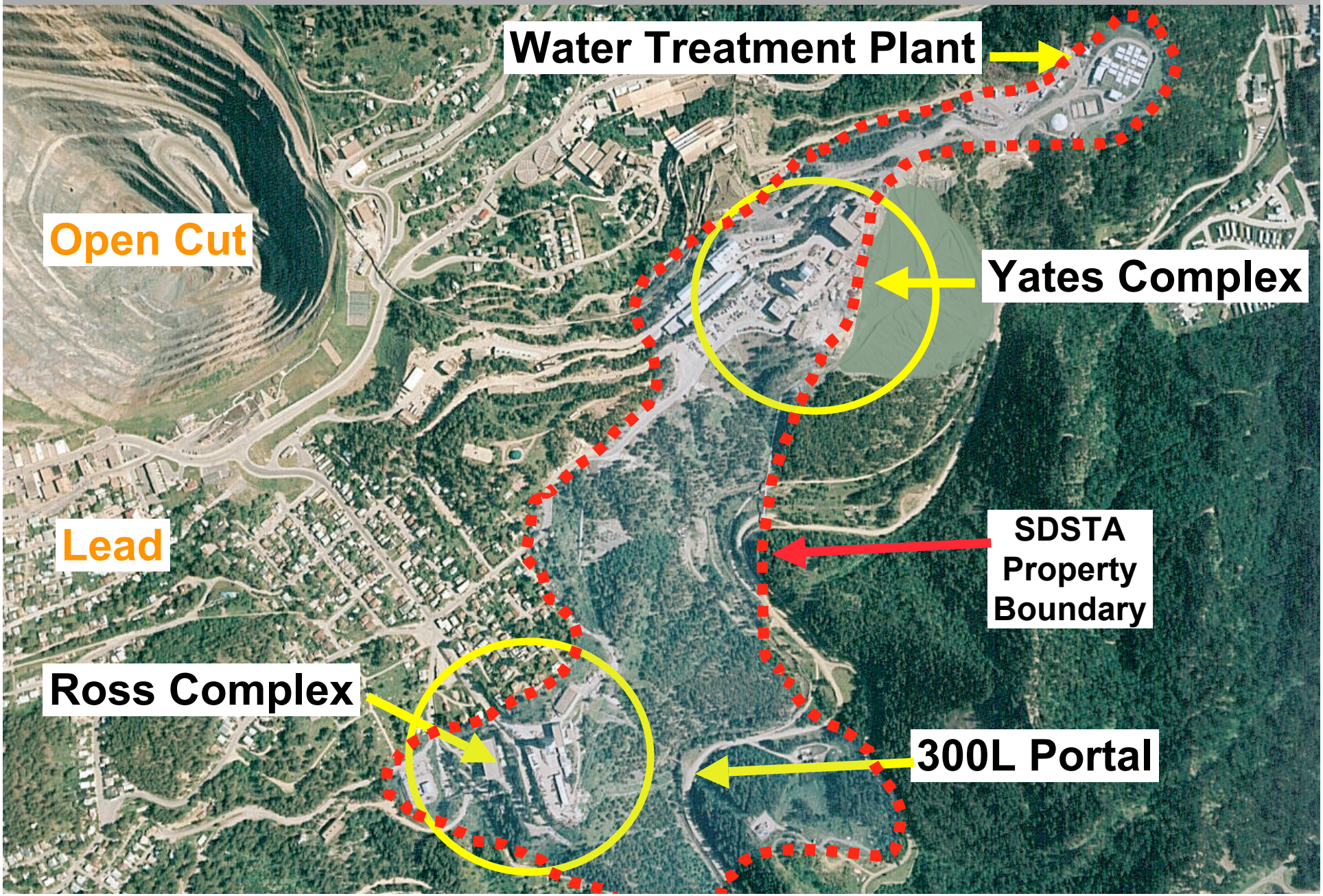
Berkeley Project Office **South Dakota Project Office**

Initial Development of the Sanford Laboratory provides access to mid-levels for early experiments

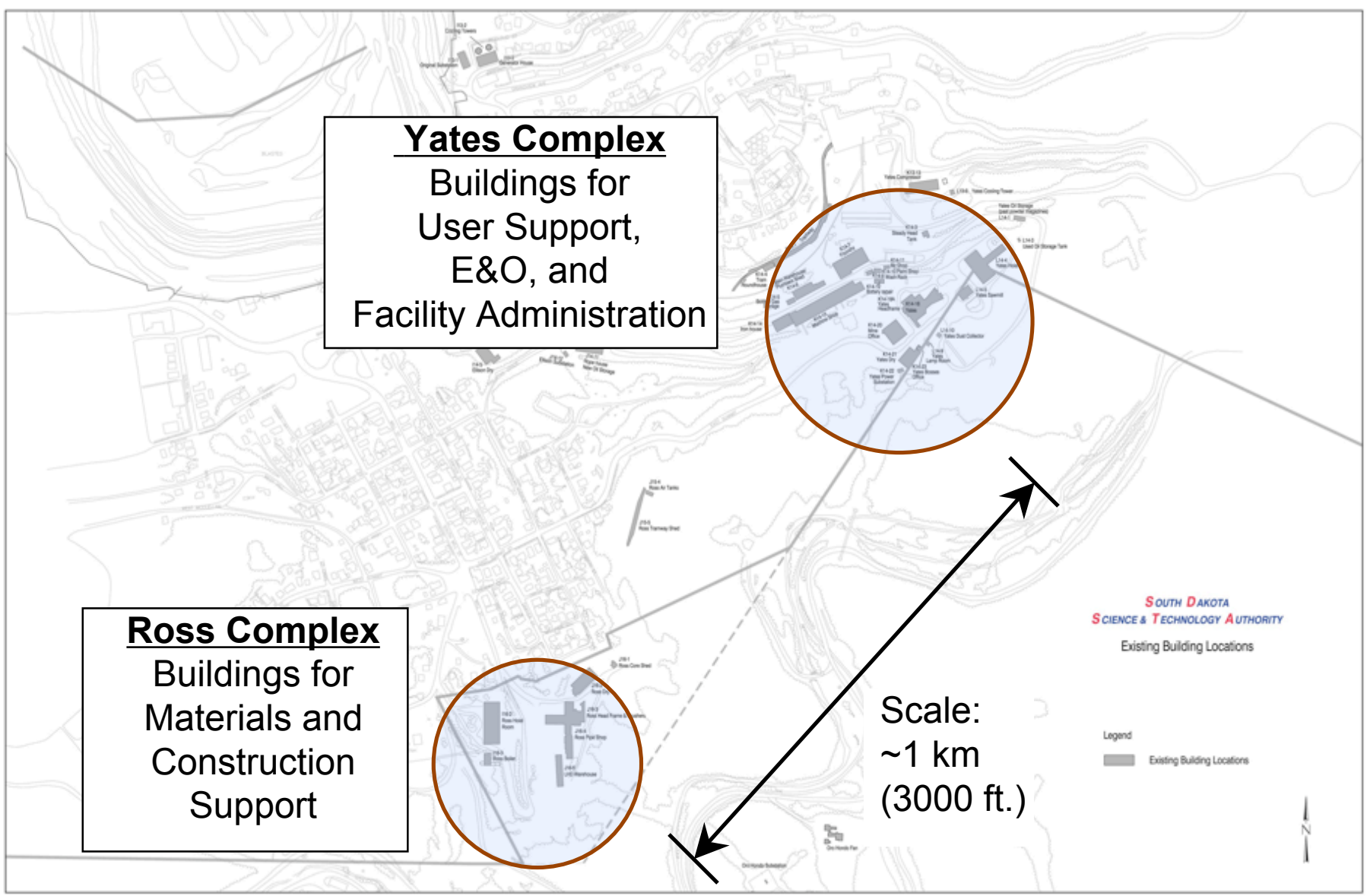


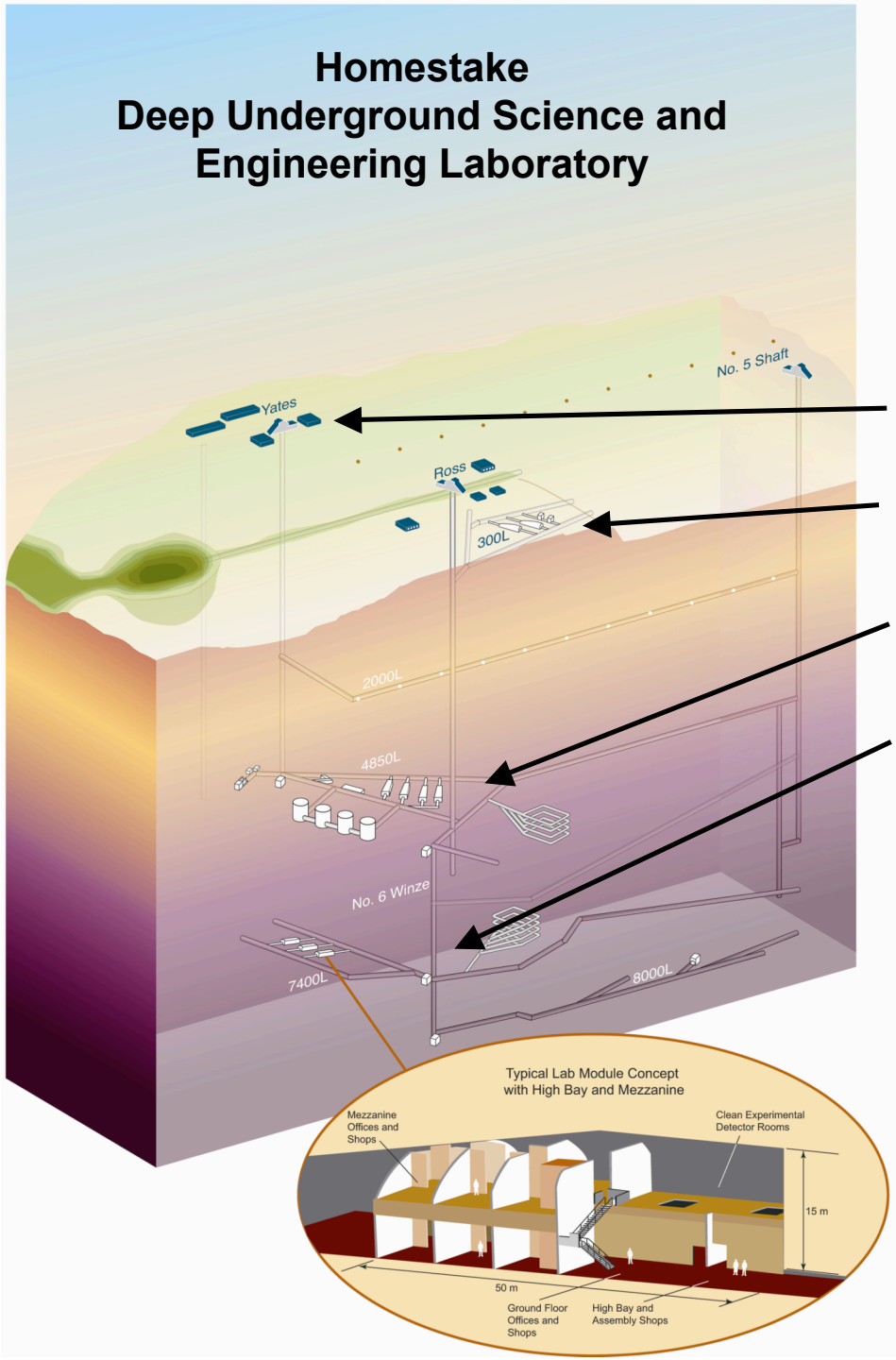
Early access to 4850 Level and above with SDSTA funding for Sanford Laboratory

Homestake and Lead Aerial Photo



Surface Campus Development Plan





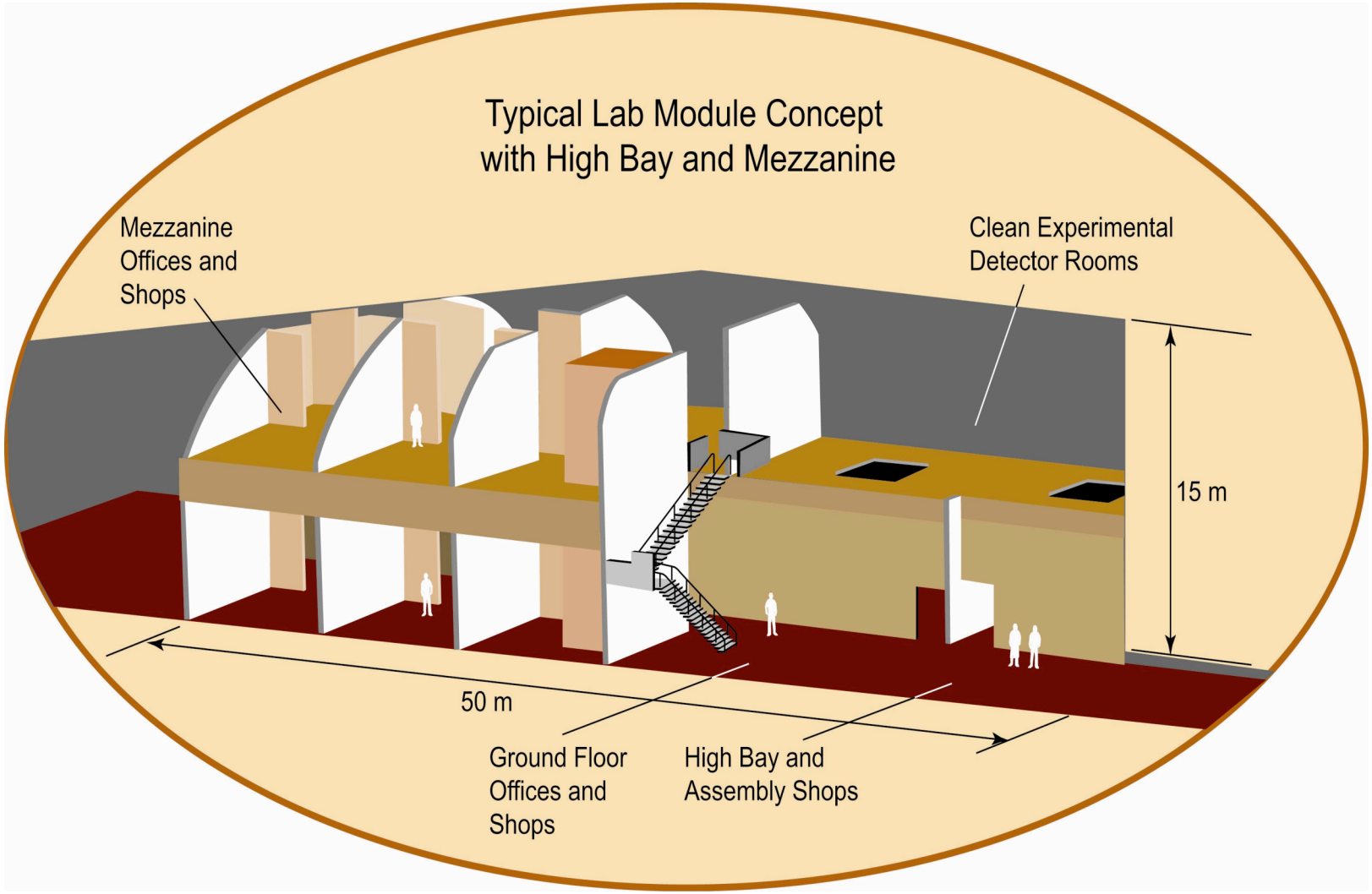
DUSEL Campus Development Summary

Conceptual plan to develop four primary campus locations for research:

- Surface campus at Yates Complex
- Near-surface campus at 300 Level
- Mid-level campus at 4850 Level
- Deep-level campus at 7400 Level

Infrastructure will be maintained for access to additional, selected levels for bio- and geo- sciences and for unique experiments that require specific or isolated sites.

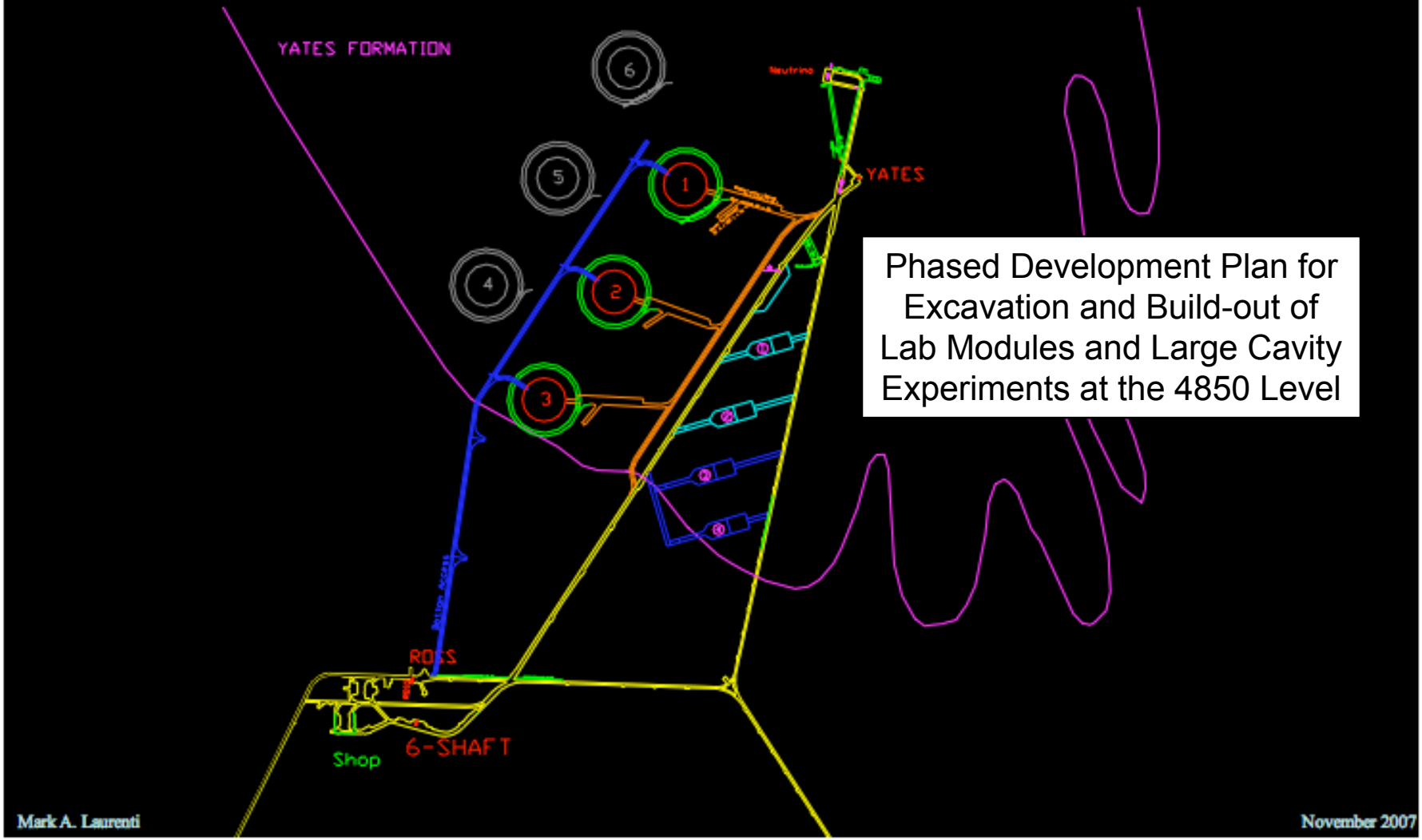
Lab Module Concept for Preliminary Analysis and Feasibility Studies



Purpose-built laboratories modules and infrastructure will be developed to match specific experimental requirements.

MEGATON MODULAR MULTI-PURPOSE NEUTRINO DETECTOR

✓ Modular Configuration



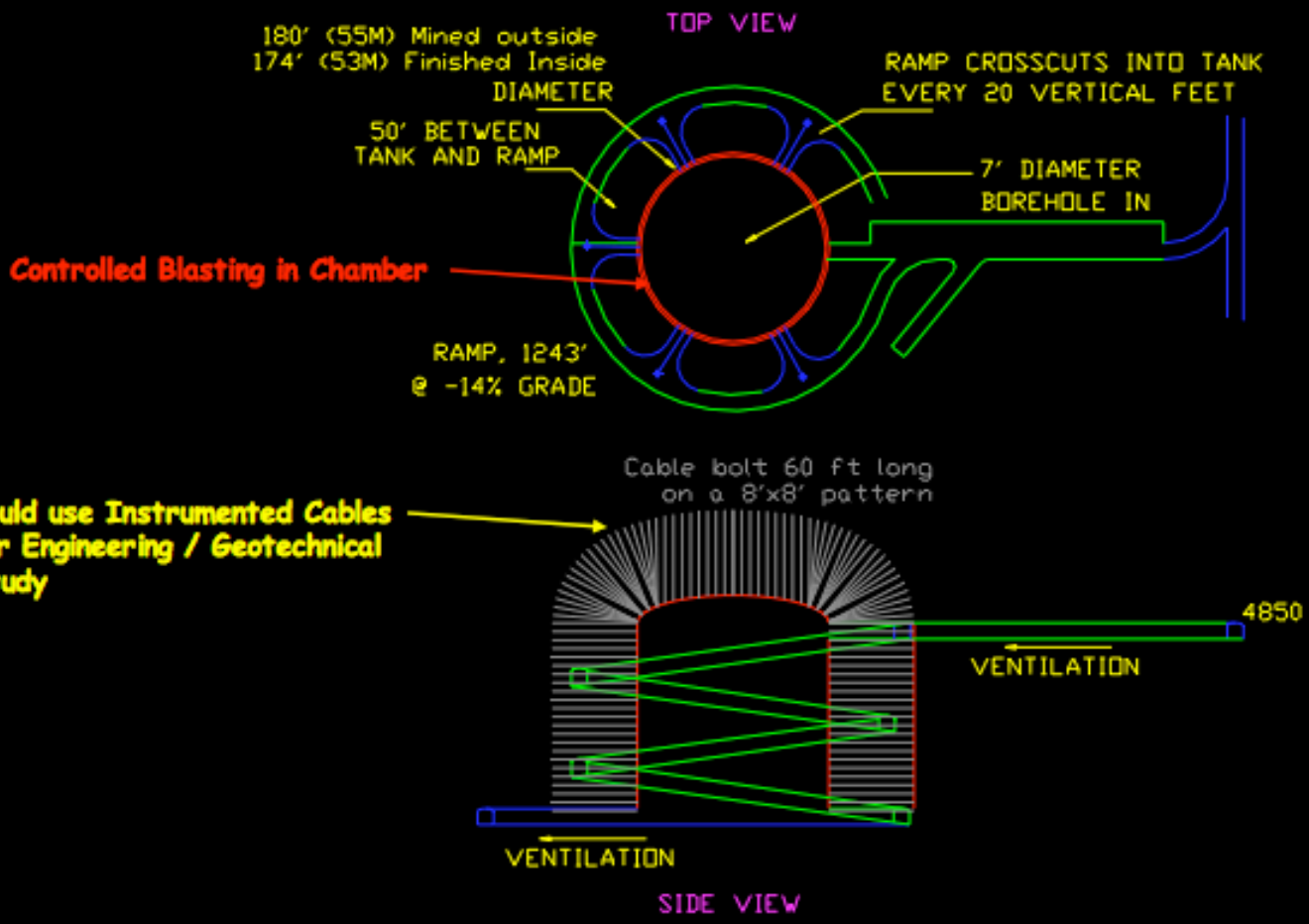
Phased Development Plan for Excavation and Build-out of Lab Modules and Large Cavity Experiments at the 4850 Level

Mark A. Laurenti

November 2007

MEGATON MODULAR MULTI-PURPOSE NEUTRINO DETECTOR

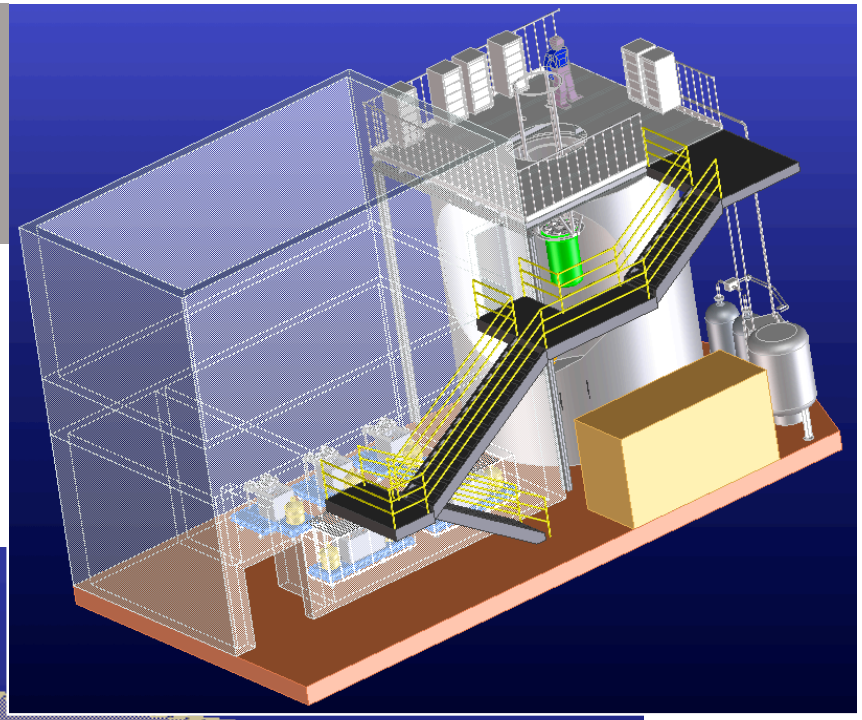
✓ Chamber Design

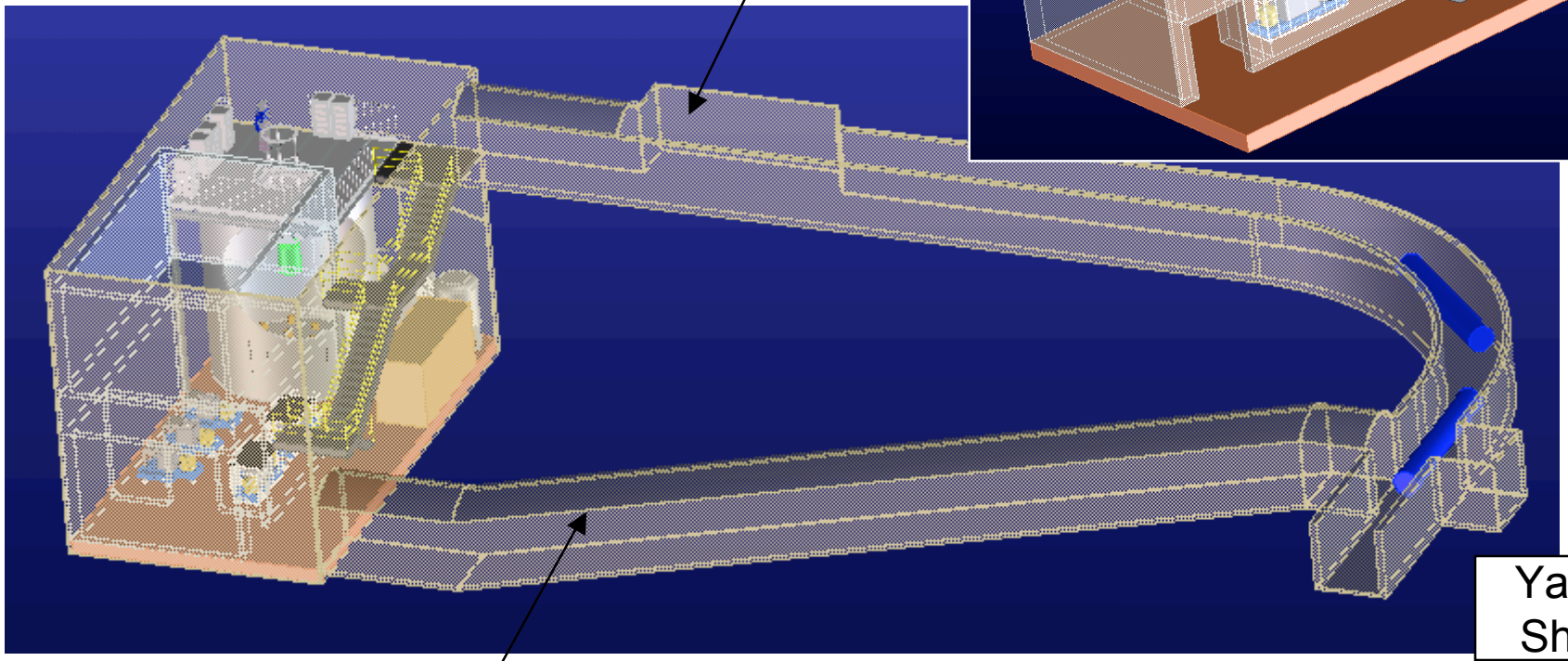


Dark Matter Experiment with Low Background Facility

Existing Davis Cavity
Dimensions:
55ft x 30ft x 32ft high

4850L
Primary
Access

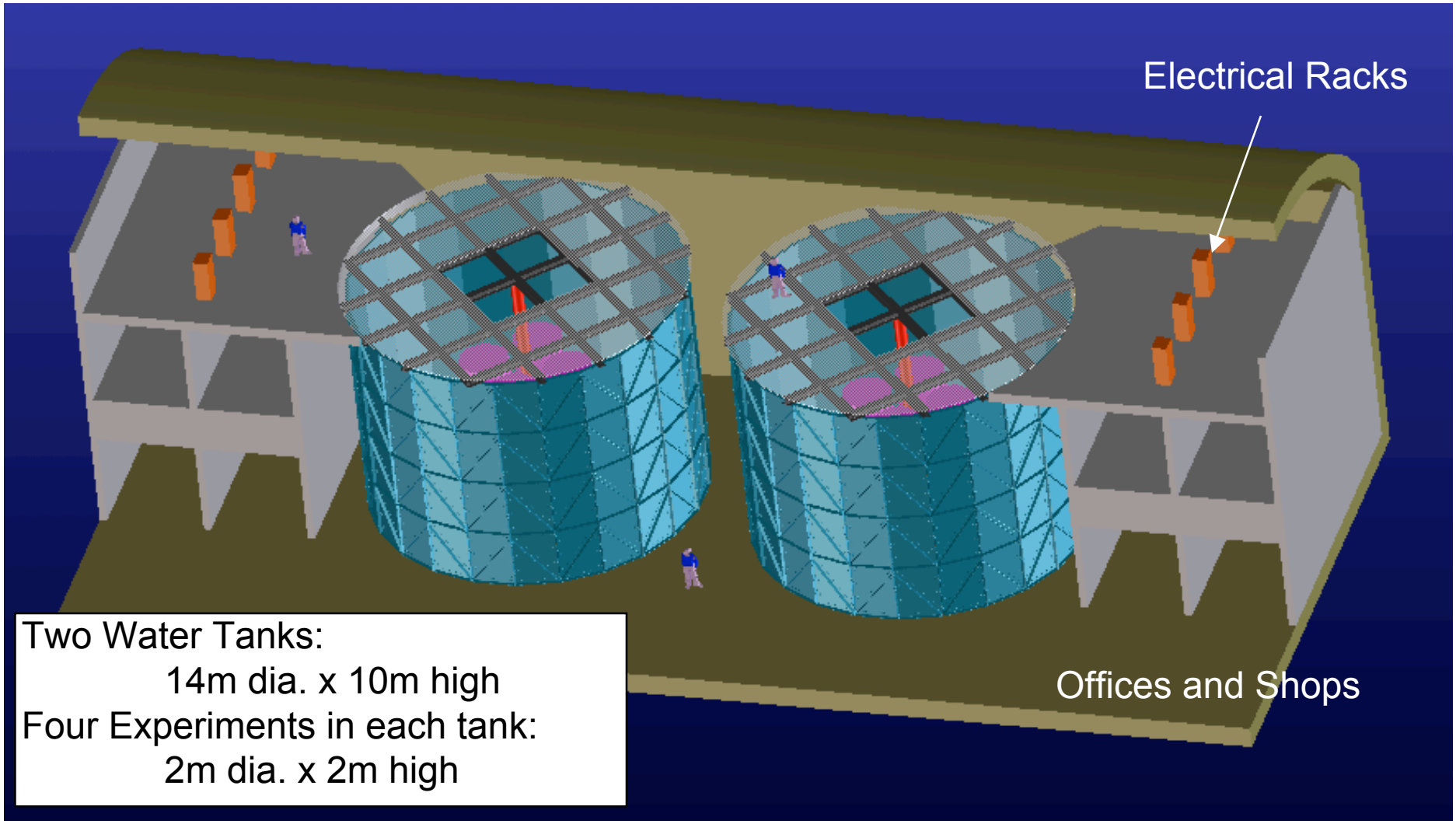




Yates
Shaft

Secondary Access

Concept for a Purpose-built Water Shield Facility for Multiple Experiments



Two Water Tanks:
14m dia. x 10m high
Four Experiments in each tank:
2m dia. x 2m high

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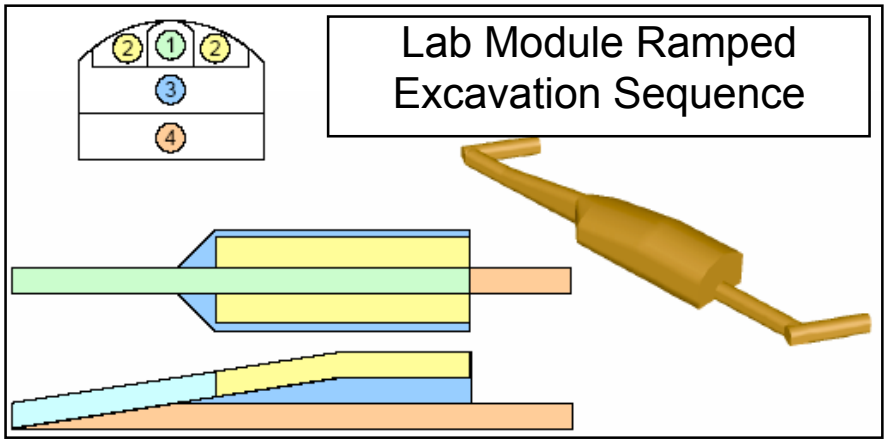
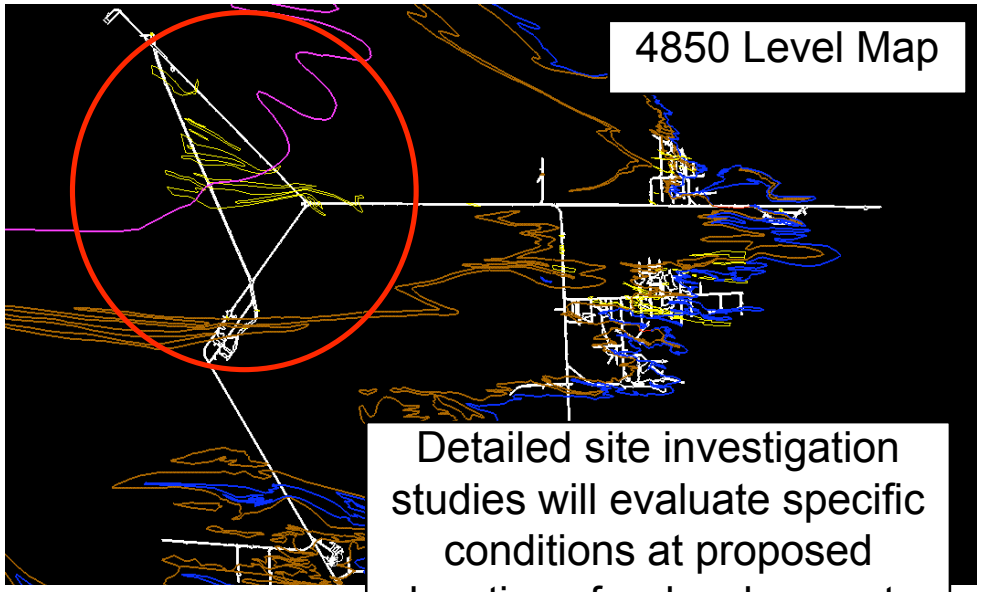
Preliminary Feasibility Studies have been done for Excavation and Ground Support for Typical Lab Modules





Detailed site investigation studies will evaluate specific conditions at proposed locations for development.

FORMATION	LEVEL	LOCATION	BOLTING	SHOTCRETE
Poorman Formation	4850L	Roof	5 m long bolts @ 2 m c/c	90 mm fibre reinforced shotcrete
		Side Walls	8 m long bolts @ 1.75 m c/c	100 mm unreinforced shotcrete
	7400L/8000L	Roof	5 m long bolts @ 1.75 m c/c	100 mm fibre reinforced shotcrete
		Side Walls	8 m long bolts @ 1.5 m c/c	90 mm fibre reinforced shotcrete
Yates Unit	4850L	Roof	5 m long spot bolts	none
		Side Walls	4 m long bolts @ 2.5 m c/c	none
	7400L/8000L	Roof	5 m long bolts @ 2.5 m c/c	none
		Side Walls	4 m long bolts @ 2.25 m c/c	50 mm unreinforced shotcrete

Preliminary Geotechnical Analyses were done to support the site selection and identify preliminary requirements for excavation and ground support requirements.

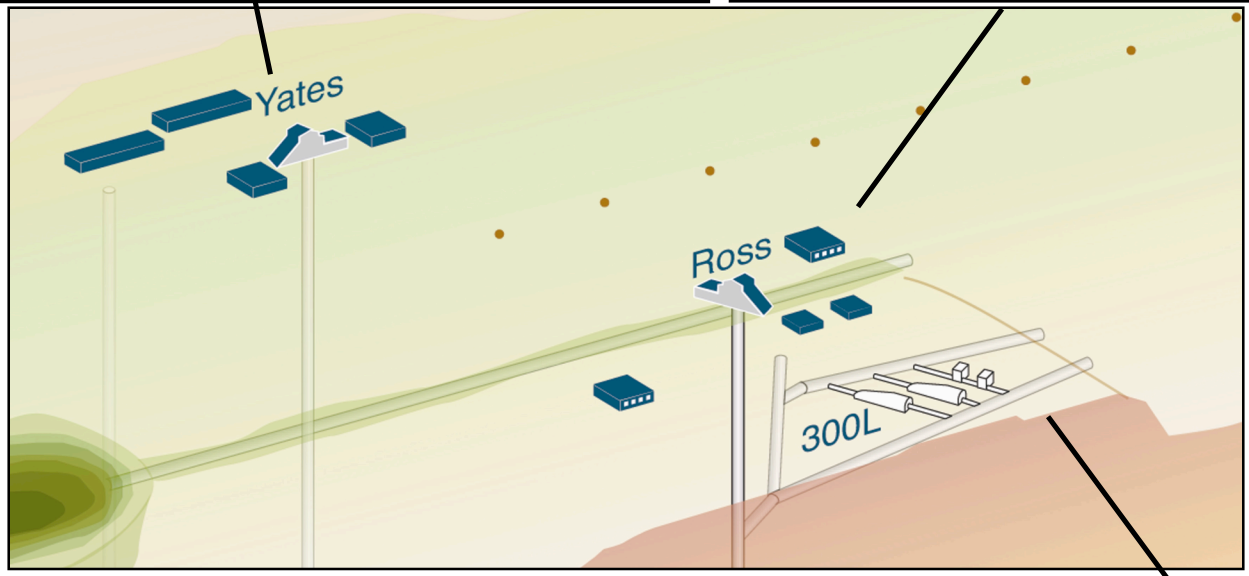
CDR Campus Development Concepts for Surface Facilities and 300 Level

Yates Complex Surface Facilities:

- Laboratory Administration Building and Training
- User Support Services: Clean Room Assembly & Fabrication Shops
- R&D Laboratories, User Offices, Meeting Rooms
- Education and Outreach: Sanford Center for Science Education
- Shipping and Receiving, Storage

Ross Complex Surface Facilities :

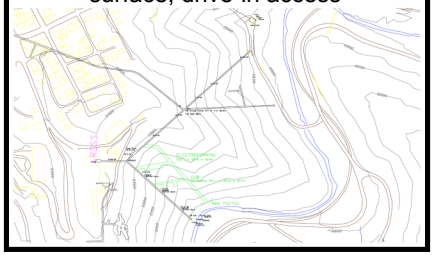
- Construction Materials and Equipment Staging
- Construction Superintendents and Contractor Offices
- Maintenance Shops
- Shipping and Receiving, Storage
- Facility Site Services and Operations



Experiments and Facilities at 300 Level:

- Education and Outreach Classroom and Laboratory
- User Support Shops: Assembly, Fabrication and Underground Storage
- Research and Development Laboratories
- Near-surface Experiments
- Low-background Counting and Calibration Facility

300 Level Campus Plan for near-surface, drive-in access



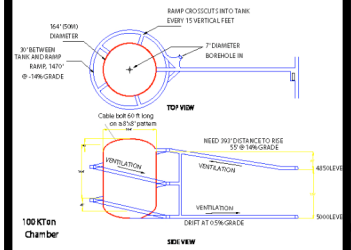
CDR Campus Development Concepts for Mid- and Deep-level Experiments

Early Implementation Program & Facility Infrastructure Development at 4850L:

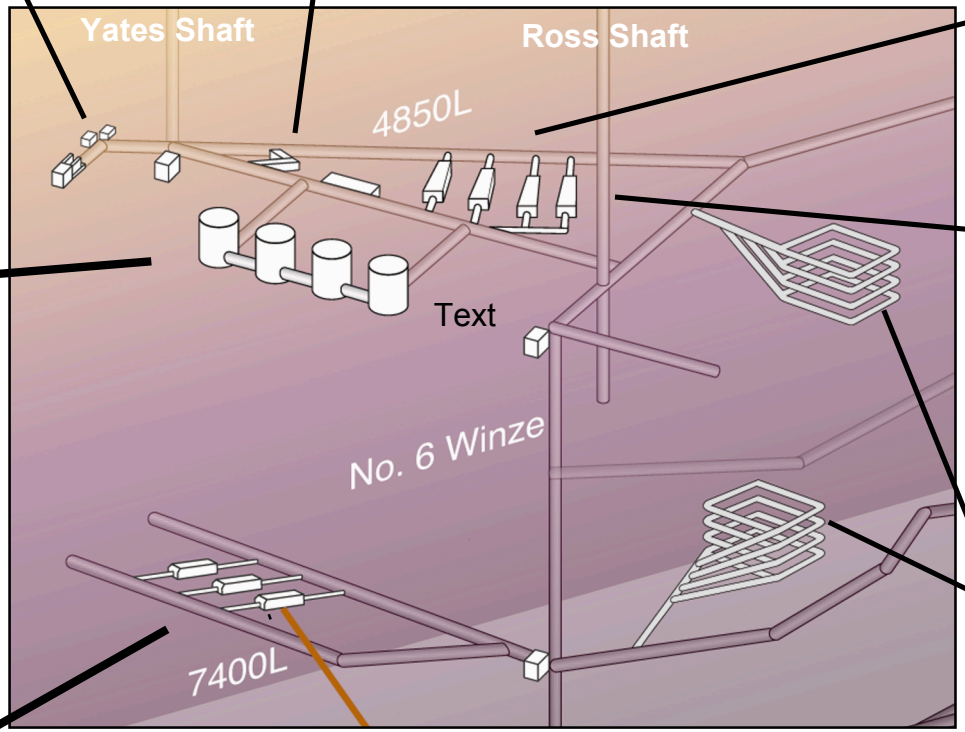
- Low-Background Counting Facility
- Neutrinoless Double Beta Decay
- Dark Matter
- Earth Sciences and Geo-microbiology Lab
- Common Facilities and Clean Room Transition
- Utility Services and Refuge Chamber

Initial Suite of Experiments at 4850 Level

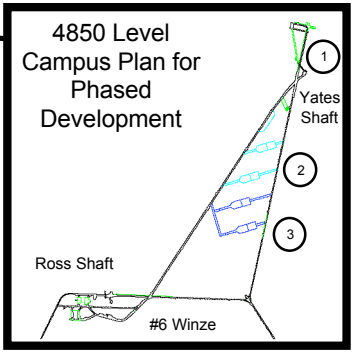
- Dark Matter
- Double Beta Decay
- Nuclear Astrophysics
- Solar Neutrinos
- Geoneutrinos



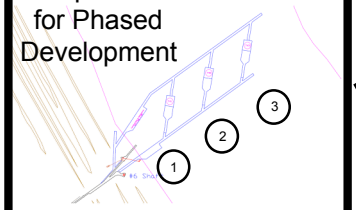
Design and Excavation concept for future, multiple 100 kTon chambers for Long Baseline Experiment



4850 Level Campus Plan for Phased Development



7400 Level Campus Plan for Phased Development



Geosciences:

Large Block Coupled-Processes Experiments

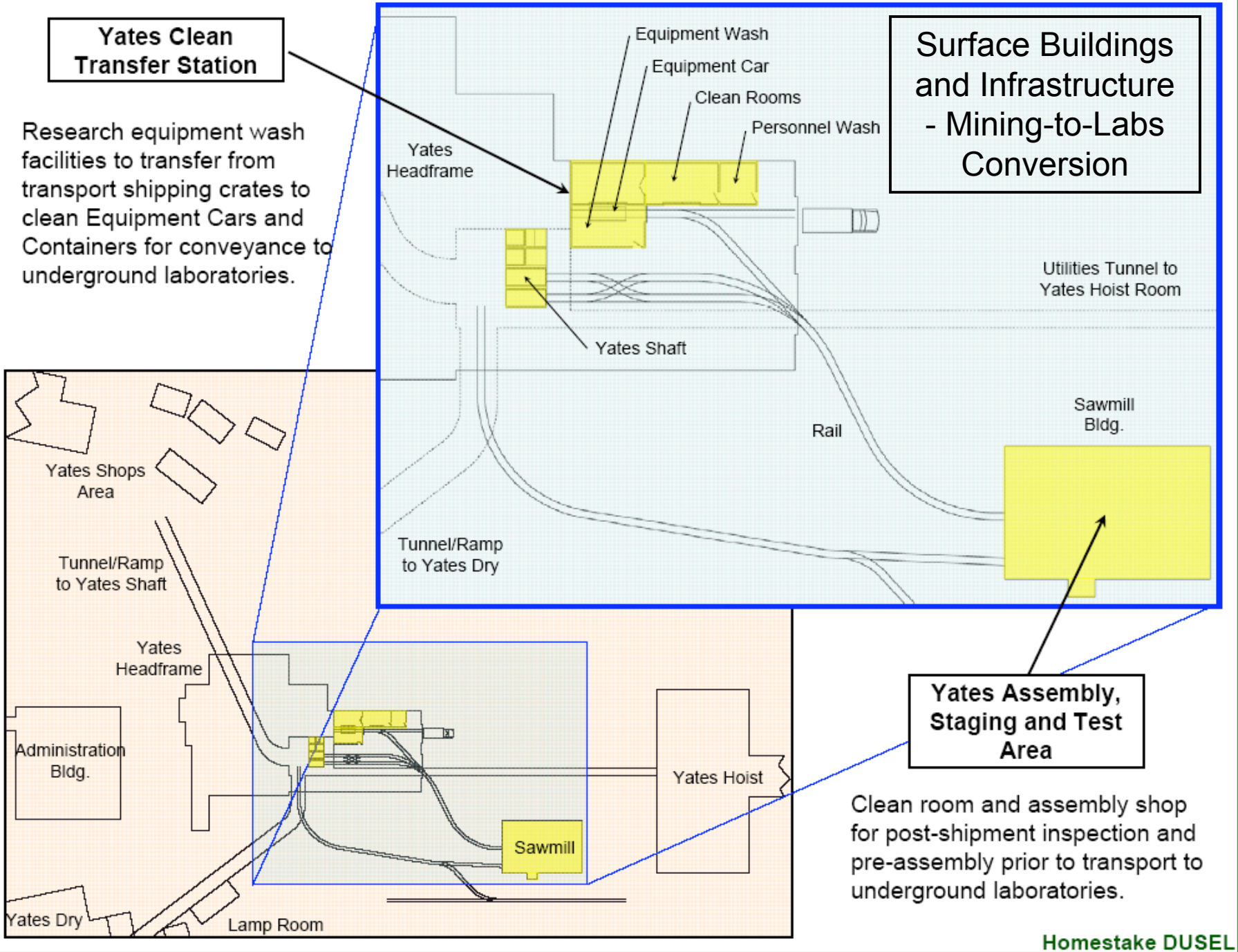
Initial Suite of Experiments at 7400 Level:

- Large Double Beta Decay
- Solar Neutrinos
- Supernovae Detection
- Large Dark Matter

Surface Buildings and Infrastructure - Mining-to-Labs Conversion

Yates Clean Transfer Station

Research equipment wash facilities to transfer from transport shipping crates to clean Equipment Cars and Containers for conveyance to underground laboratories.



Yates Assembly, Staging and Test Area

Clean room and assembly shop for post-shipment inspection and pre-assembly prior to transport to underground laboratories.

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Proposed Development Program for DUSEL

Rehabilitation and construction during 2008 to 2011 for the SDSTA Sanford Lab will provide space for early experiments, followed by ~6 years of phased construction for DUSEL with project completion by 2018.

Sanford Laboratory and DUSEL Summary of Development of Space and Availability (Underground space fully outfitted and ready for detector installation)	Labs, Shops, Offices Usable Floor Area		Excavation Volume (including access drifts)	
	sq. ft.	sq. m.	cu. yd.	cu. m.
4850 Level Subtotal	**107,351**	**9,973**	**111,115**	**84,903**
Ross Shops for Construction Staging	12,469	1,158	5,738	4,385
Davis Lab, Sanford Lab, and Bio-Geo Lab	15,738	1,462	13,543	10,348
Lab Module #1 and Common Facilities	26,464	2,459	25,155	19,221
Lab Module #2	17,560	1,631	21,433	16,377
Lab Module #3	17,560	1,631	23,121	17,667
Lab Module #4 (excavation only, without lab outfitting)	17,560	1,631	22,125	16,906
7400 Level Subtotal	**63,588**	**5,907**	**98,477**	**75,246**
Lab Module #1 and Common Facilities	28,468	2,645	29,594	22,613
Lab Modules #2 and #3 (excavation only, without lab outfitting)	35,120	3,263	68,883	52,633
300 Level Subtotal	**8,668**	**805**	**14,007**	**10,703**
Lab #1, Shops, and E&O Rooms	8,668	805	14,007	10,703
Surface Subtotal	**98,000**	**9,104**		
DUSEL Offices and User Support Areas,Phase 1	10,000	929		
Sanford Clean Room and Assembly Shop	6,000	557		
DUSEL Offices and User Support Areas,Phase 2	32,000	2,973		
Sanford Center for Science Education	50,000	4,645		
Total	**277,607**	**25,790**	**223,599**	**170,852**

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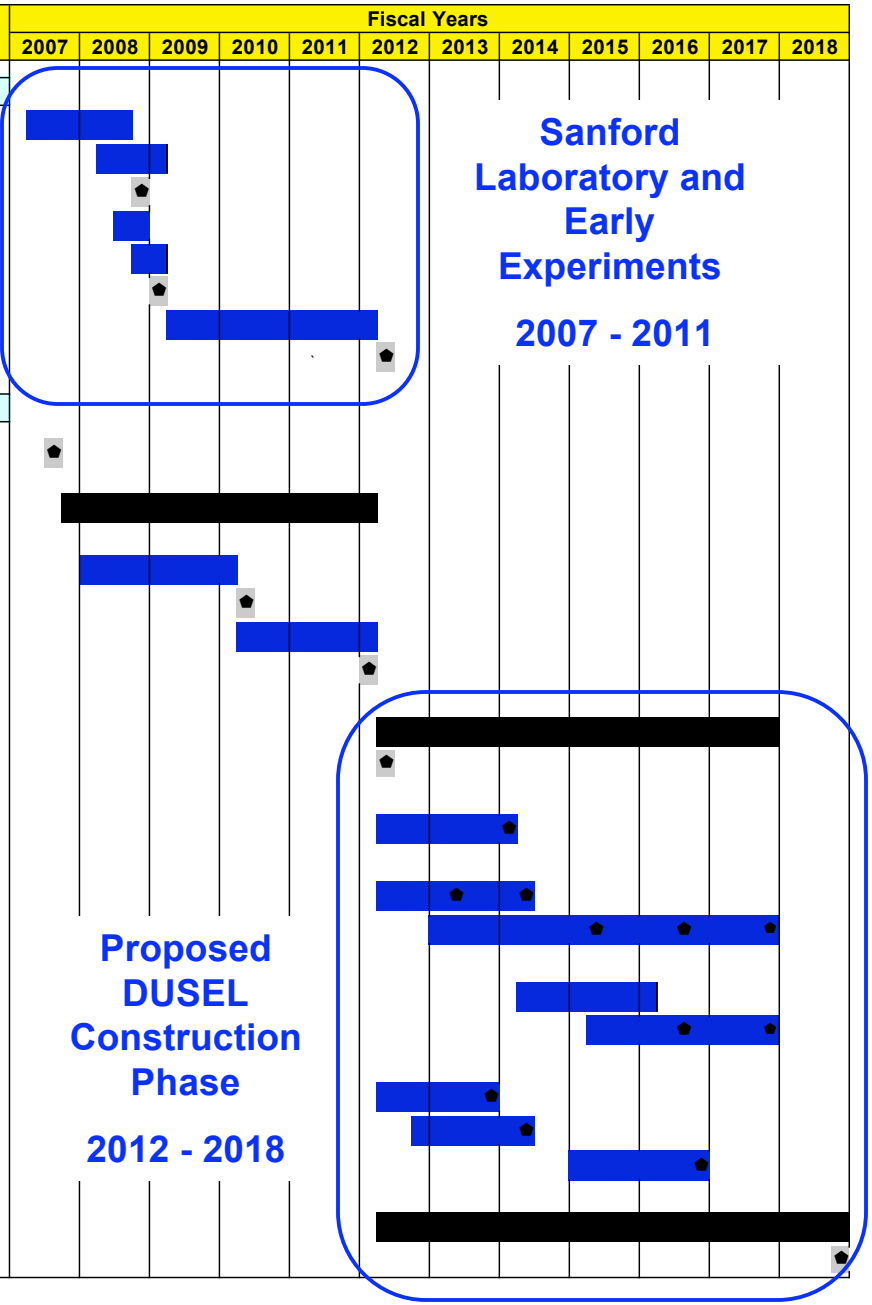
Preliminary Cost Profiles
by Subproject
(Combined funding from all sources)

	Estimated Project Total Cost (FY07-$, Without Contingency) $K	Contingency (%) %	Estimated Project Total Cost (FY07-$, Incl. Contingency) $K	Cost Distribution %	TOTAL Escalated Then-Year-$K $K
Homestake Interim Lab and DUSEL Subprojects					
1. Mining-to-Labs Conversion: Facility Rehabilitation, Re-entry, and Construction	$ 39,860	25%	$ 49,802	15%	**$ 52,511**
2. Surface Buildings and Infrastructure: Alterations and upgrades for facility operations, site services, and user support	$ 25,677	29%	$ 33,097	10%	**$ 39,482**
3. Sanford Center for Science Education	$ 15,562	20%	$ 18,660	6%	**$ 20,509**
4. Underground Excavation for development of laboratory space and common facilities	$ 68,319	29%	$ 88,253	27%	**$ 102,984**
5. Underground Laboratories: Facilities and Infrastructure, Utilities and Services for Research Laboratories	$ 90,995	28%	$ 116,846	35%	**$ 136,744**
Project Support (Management and Staff)	$ 22,315	14%	$ 25,347	8%	**$ 28,597**
Subtotal: HIL and DUSEL Subprojects	**$ 262,727**	26%	**$ 332,004**	**100%**	**$ 380,828**
BUDGET for Science and Engineering Research: Experimental Systems and Research Equipment Design, Construction, and Installation	$ 223,400		$ 223,400		**$ 259,343**
HIL and DUSEL Project Total Estimated Cost	$ 486,127		$ 555,404		**$ 640,171**

$K

Proposed Timeline for Sanford Laboratory and DUSEL	Start	Finish
Sanford Laboratory at Homestake		
Ross Shaft Rehab and Pumping Column Commissioning	Jan-07	May-08
Yates Shaft Rehab.	Mar-08	Dec-08
Gain safe access to 4850L for EIP construction start, and hold water level at 5000L		Jun-08
Install facility infrastructure for Davis Lab early experiments	May-08	Sep-08
Install and commission research instrumentation in Davis Lab	Jul-08	Dec-08
Early experiments in Davis Lab ready for operation		Dec-08
Continued rehabilitation and infrastructure upgrades for Sanford Lab		Dec-11
Transition from Sanford Lab to DUSEL Operations		Jan-12
NSF Deep Underground Science and Engineering Laboratory at Homestake		
Homestake site selection announcement		Jul-07
DUSEL Preconstruction Planning and Development (R&RA)	**Oct-07**	**Dec-11**
Preliminary Design Phase to develop Baseline Cost and Schedule	Oct-07	Dec-09
Preliminary Design Review and National Science Board Recommendation		Mar-10
Final Design Phase	Mar-10	Dec-11
Final Design Review and Authorization for Construction Start		Dec-11
DUSEL Facility - Construction and Commissioning (MREFC)	**Jan-12**	**Sep-17**
Construction Start		Jan-12
Near-Surface Campus Construction at 300L		
300L Laboratories and Education and Outreach Facilities	Jan-12	Dec-13
Mid-Level Campus Construction at 4850 Level		
4850L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-12	Jan-14
4850L Lab Modules #2, #3 and #4	Oct-12	Jul-17
Deep-Level Campus Construction at 7400 Level		
7400L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-14	Dec-15
7400L Lab Modules #2 and #3	Jun-15	Jul-17
Surface Campus Construction		
Infrastructure to support Underground Construction and Operations	Jan-12	Sep-13
Phase 1 Offices and Laboratories	Jul-12	Mar-13
Phase 2 Offices and Laboratories	Oct-14	Sep-16
DUSEL Initial Suite of Experiments - Construction and Commissioning	**Jan-12**	**Sep-18**
MREFC Construction Finish		Sep-18




Fine